The temporal composition of task-specific and reward related memory components in free-flying honeybees

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Single honeybees were trained to collect sucrose solution from patches of two, four, and eight artificial feeders. In this experimental paradigm various behavioral parameters were analyzed to unravel the role of memory components with respect to the natural foraging behavior. The duration of proboscis extension was found to be an excellent measure of both the bee´s expectancy and its momentary evaluation of the sucrose stimulus. The duration of proboscis extension at any visit partially depends on the duration of proboscis extension at earlier visits in sequence. This demonstrates that the momentary response to sucrose depends on the retrieval of memories reflecting the bee´s experience at feeders visited previously. The strength of this correlation is, however, a function of the time interval elapsing between two successive visits to the same particular feeder (revisit interval).
This analysis allows to determine the time course of different memory components which are specific to individual feeders in the patch and which are in addition specific to the total number of feeders and the reward distribution.
A long-lasting memory component was identified on revisits (visits to the same particular feeder) which is characterized by two different temporal phases. During the first 120 sec (phase 1) the retrieval of the feeder-specific memory is more limited when compared to much longer revisit intervals in phase 2. This rule dominates for patches with four and eight feeders whereas in the dual choice situation the retrieval of memory is more marked during phase 1. In experiments with four feeders which differed either in their overall rewarding rate or in the reward ratio of the individual feeders, the time course of the two phases was found to be stable. These results reflect an intrinsic biphasic memory process with a relatively constant time course, independent of the complexity of the task.
The isolation of task-specific memory components and their exact time courses will allow a development of a mechanistic model of the formation and interaction of different memories which guide the bee's choice behaviour during foraging.

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